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DAMAGE TO PONDEROSA PINE SEED CROPS BY THE CONE MOTH LASPEYRESIA MISCITATA HEINRICH IN NORTHERN IDAHO

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INTRODUCTION

During the month of March 1934, in the vicinity of Coeur d'Alene, Idaho, a large number of ponderosa pine cones lying on the ground near the base of the trees showed a heavy seed loss due to cone insects. A collection of 100 cones was made by the writer at that time and placed in a light-proof rearing cage to which glass collecting jars had been fitted. The cage was then placed in a warm room. During the second week in April 1934 a heavy emergence was secured from the cones. It was found that the insect responsible for the seed loss was the ponderosa pine cone moth Laspeyresia miscitata Hein., the maturing seed being destroyed by the feeding activities of the larvae of this moth. In addition to the emergence of the moths, six different species of its parasites were secured and sent to the U. S. National Museum for identification. No definite estimate of the seed loss to the 1932-33 cone crop was made at that time. In the spring of 1935 a much heavier infestation was found in the 1933-34 fallen cones. At this time a study was started to determine the range of the infestation and to secure an estimate of the seed loss caused by this insect in local ponderosa pine stands.

VALUE OF PONDEROSA PINE SEED

Ponderosa pine seed has a high commercial value, owing to the

irregular cone crop and to the heavy loss of seeds due to the feeding activities of several species of birds, squirrels, and insects, as well as to the loss occasioned by infertile seeds apparently caused by lack of pollenization. Ponderosa pine seeds are particularly valuable as a source of planting stock for reforesting large burned-over areas and to insure natural reproduction on the heavily logged and wood-cutting areas throughout the stands.

METHOD OF STUDY TO DETERMINE SEED LOSS BY INSECTS

During the period of April 17 to 28, 1935, one hundred ponderosa pine cones were collected by random selection from each of ten different plots averaging approximately one acre each. The cones were collected from the ground near the base of the trees. They were tightly closed owing to moisture acquired during the winter months and showed no outward indications of insect attack. The 1933-34 cones could be determined by their bright color as compared to the faded color of cones of the previous year. Fifty of the cones from each plot were halved and examined for insect attack at the time and place of collection, and the remaining fifty were placed in a light-proof cage fitted with a glass jar for noting emergence and for convenience in collecting the insects. These cages were kept outdoors in a screened insectary during the entire time of the study, which lasted from April 1935 until July 1936. Data from the ten plots just discussed are presented in the following tabulation:

Table I

DESCRIPTION OF ONE-ACRE PLOTS

Plot No.	Description of site	No. of trees from which cones were collected	D.B.H. of cone-bearing trees	Size of Cones in length	Remarks
1	Dry gravelly flat	10	20-28"	3 1/2-4 1/2"	Edge of logged area
2	East-facing slope	14	10-14"	2 1/4-3"	Dense even-aged stand
3	Dry gravelly flat	6	18-30"	3 1/2-4 1/2"	Edge of logged area
4	Rocky west-facing Slope	8	18-32"	3-3 1/2"	Open stand
5	Dry gravelly flat	10	12-18"	3-3 1/2"	Old logged area
6	Rocky South-facing slope	8	12-18"	3-3 1/2"	Old logged area
7	West-facing slope	6	20-48"	3-3 1/2"	Open Stand
8	Dry gravelly flat	10	10-16"	2 1/2-3 1/4"	Old logged area
9	South-facing slope	8	16-30"	3-3 1/2"	Brushy hillside
10	Rocky south-facing slope	6	18-24"	3 1/2-4 1/2"	Brushy hillside

These plots represent the various sites, exposures, and diameters of the ponderosa pine over an area of fourteen square miles, and with the random selection of 1,000 cones it is believed a fairly representative estimate of the 1933-34 seed loss was secured.

The results obtained from the rearing experiment are given in the following table.

Table II

NUMBER OF CONE MOTHS (LASPEYRESIA MISCITATA HEINRICH) AND ASSOCIATED PARASITES EMERGING FROM 500 CONES IN CAGES, 50 EACH FROM 10 DIFFERENT PLOTS, COLLECTED DURING APRIL 1935

Emergence from Plot	1	2	3	4	5	6	7	8	9	10	Total
1935											
(Cone moth)											
Laspeyresia miscitata	86	7	81	20	24	18	56	49	43	48	432
(Parasites)											
Calliephialtes comstockii	2	—	3	3	—	2	1	1	1	6	19
Phanertoma laspeyresiae	5	—	—	—	—	—	—	—	—	—	5
Apanteles laspeyresiae	132	—	3	10	32	18	24	23	2	11	255
Meloboris laspeyresiae	1	—	—	1	—	1	—	—	—	2	5
Amblymerus verditor	26	—	—	3	—	—	6	3	3	—	41
Elachertus evetriae	6	—	2	6	1	4	56	—	—	19	94
1936											
(Cone moth)											
Laspeyresia miscitata	38	14	85	30	28	18	78	*	35	47	373
(Parasites)											
Calliephialtes comstockii	1	—	1	—	—	—	1	—	1	2	6
Phanertoma laspeyresiae	—	—	—	—	—	—	—	—	—	—	—
Apanteles laspeyresiae	50	1	7	16	20	6	31	—	1	3	135
Meloboris laspeyresiae	2	—	—	—	—	—	1	—	—	—	3
Amblymerus verditor	20	—	—	24	—	—	13	—	—	—	57
Elachertus evetriae	—	—	—	—	—	—	—	—	—	—	—
Total no. of cone moths for 1935 and 1936	124	21	166	50	52	36	134	49	78	95	805
Total No. of parasites for 1935 and 1936	245	1	16	63	53	31	133	27	8	43	620

* Cones opened in October 1935--26 live cone moth larvae still remaining in cores.

Emergence of parasites from three of the cages started a few days after the cones were collected, but emergence of the cone moths in 1935 did not start until May 20th, or approximately one month after collection. The emergence of the moths began practically simultaneously and continued proportionately quite constant from all ten cages during the entire emergence period, although the degree of infestation varied considerably between areas. The emergence of parasites while starting before the moths was more erratic and lasted over a much longer period of time, no doubt because of the different developmental period required by each species.

None of the cones were disturbed until October 1935, at which time it was thought the emergence was complete. The cage containing cones from plot number eight was selected at random for examination. Upon opening active cone moth larvae were still found to be present, amounting to 26 for the 50 cones. Field examinations of infested cones in October and November 1935, and again in March and April 1936, also showed cone moth larvae still present. The nine undisturbed cages in which the cones had fully opened during the summer were subjected to a severe spell of cold weather during February 1936, with temperatures as low as -17°F. A simultaneous emergence in 1936 of cone moths from the nine cages began ten days earlier than for the previous season and continued sporadically until June 11, 1936. Emergence of parasites began at the same time and continued during the emergence period of the moths. A comparison of the 1935 and 1936 emergence as shown in table 2 gives the total

emergence of both moths and associated parasites for the two seasons. With five of the cages the 1936 cone moth emergence exceeded that of 1935, with one cage equal in number and three with less. No account is taken of the probable emergence that would have occurred from the 26 live larvae found in cage 8. The emergence of parasites, while much less in number than for 1935, was a little heavier per emerging cone moth than for the previous season. The most important feature of the emergence record is the ability of the cone moths and most of their associated parasites to carry over two seasons, thus protecting themselves against a poor cone crop such as noted for 1934-35. If the emergence had been complete in 1935, no doubt there would have been a very heavy mortality of the cone moths owing to lack of host material.

The percent of infested cones and corresponding seed loss for the ten cages and plots are presented in the following table.

Table III

PERCENT OF INFESTED PONDEROSA PINE CONES
AND SEED LOSS FOR THE TEN CAGES AND
THE CHECK PLOTS

Plot number	Cone Examinations: Field: 50 Cones examined: No. infested	Cages: 50 Cones in cage: No. infested	Total percent of both	Estimate of the total no. of ~~fertile~~ uninfested* seeds from 50 cones in cage	No. of seeds destroyed by the cone moth larvae in 50 cones in cage	Percent of destroyed seed
1	50	48	98	3,314	2,054	62.0
2	24	18	42	2,850	174	6.1
3	44	48	92	4,480	1,088	24.3
4	48	45	93	3,350	1,012	30.2
5	50	47	97	4,560	1,204	26.4
6	49	48	97	3,530	867	24.6
7	47	47	94	3,590	1,009	28.1
8	48	49	97	3,840	1,165	30.3
9	46	42	88	3,015	804	26.7
10	50	47	97	4,070	1,053	25.9
Total infested cones	456 = 91.2%	439 = 87.8%	Average percent: 89.5	36,239	10,430	Average percent 28.5
Total uninfested cones	44 = 8.8%	61 = 12.2%				

* Uninfested seeds.

Table number 3 showed 456 infested cones out of 500 examined in the field, and in the cages 439 out of 500, making a total of 895 out of 1,000, or 89.5 percent.

The average seed loss per plot based on the ten plots was 28.5 percent. Eight of the plots numbering 3 to 10 inclusive were fairly constant in percent of loss, the greatest variation occurring with plots number 1 and 2. Plot number 1 proved to be the most heavily infested area selected. The cones were large and the 50 that were opened and examined in the field at the time of collection showed an average of six cone moth larvae per cone. This plot also showed the heaviest parasitism, and the only one from which the species Phanerotoma laspeyresia was reared. Plot number 2 showed the least infestation and number of parasites. This area from which the smallest cones were collected also differed somewhat from all the others. The cone-bearing trees were small and growing in a dense, even-aged stand on a bench half way up a steep hillside having an eastern exposure, where but little sunlight can penetrate the crown canopy. This type of stand was apparently not as susceptible to cone moth attack as the more open stands growing on the flats.

HISTORY OF THE CONE MOTH LASPEYRESIA MISCITATA HEIN.

The original description of this new species is found in the U. S. National Museum Bulletin No. 132, issued in 1926. It is believed to be an intermediate between Laspeyresia piperana K. and

Hedulia injectiva Hein. L. piperana was described from a type specimen collected from ponderosa pine at Pullman, Wash.; H. injectiva from Reno, Nevada, food plant Pinus. A good series of the moths reared from the ponderosa pine cones of this vicinity were identified by Mr. Carl Heinrich as the new species Laspeyresia miscitata. The type locality of L. miscitata is given as Shasta National Forest, California, food plants Pinus ponderosa and P. jeffreyi. The bulletin also states that specimens were reared from ponderosa pine in Oregon, California, and Nevada, so it is probable that this cone moth has a range equal to that of its preferred host, the ponderosa pine.

OBSERVATIONS ON SEASONAL HISTORY OF THE CONE MOTH L. MISCITATA HEIN.

Oviposition by this moth was not observed by the writer, but as emergence was found to occur during the month of May for the two seasons after attack, the eggs are undoubtedly deposited during the latter part of May and early in June on the soft-bodied cones which started the year previous, as it requires on an average of 452 days for ponderosa pine cones to reach maturity from the time of the start. This average was secured from five years' phenological observations by the writer in this vicinity. The young larvae bore into the cone and begin feeding on the forming seeds which are confined in a layer surrounding the core. By the time the shell covering of the seeds begins to harden and turn brown in color the larvae are half grown. The entire contents of from 12 to 14 seeds is consumed by each larva during the complete feeding period, which lasts until

they have attained full growth and the cones are mature and begin to open. With the cessation of feeding the larvae bore short tunnels parallel to and within the core of the cone. These tunnels are lined with fine frass and then with a silken covering woven by the larva and are used first for hibernation and later as pupal chambers by many of the larvae, others using the empty seed coverings which still adhere to the base of the scales. The time of opening of the mature cones and seed shedding varies from the middle of August to the middle of September. By this time the total seed loss caused by the feeding activities of the cone moth larvae can be estimated for the current year's cone crop. Very few of the infested seeds fall from the cones. The heavily infested cones are the first to fall, probably due to the complete drying out and weakening of the core. As many as 90 percent of the cones have been found to fall during the first few days after the cones have opened, the remaining infested cones on the trees usually showing but few larvae present. The long dormant period from one season to another, practically a year, is spent in the larval stage. This condition was represented by 46 percent of the larvae in the 1933-34 cones.

The pupal stadium was not observed, but is believed to vary considerably and to be greatly influenced by air temperatures. As stated under table 2, emergence in 1935 was simultaneous in all cages beginning May 20th. During the period of May 20-24th the maximum air temperature averaged 80°F. This average maximum was recorded for

the period May 9-14th in 1936, during which time a corresponding simultaneous emergence occurred in all the nine cages and continued heavy during this period, slowing down as the daily maximum temperature receded. Complete emergence was not recorded until June 11, 1936.

SEASONAL HISTORY OF THE ASSOCIATED PARASITES

No observations were made on the seasonal history of the six species of parasites reared in association with the cone moth larvae other than that secured from emergence records.

Apanteles laspeyresiae, the most abundant parasite, was the first to emerge both seasons, nearly a month in advance of its host, continuing sporadically practically throughout the emergence period of its host during the two seasons. Emergence of two of the parasite species, namely, Phanerotoma laspeyresiae and Elachertus evetriae, was completed during the first season. A heavy mortality to the cone moth larvae results from the associated parasites, particularly with emergence during off years for seed crops.

COMMERCIAL SEED COLLECTING

In contemplating commercial seed collecting from an area known to be infested by Laspeyresia miscitata, maturing cones on the trees can be examined during the first week in August, and a general idea of cone moth infestation can be determined by the number of infested cones and the percent of infestation by the number of cone moth larvae present, each larvae destroying on an average of from 12 to 14 seeds.

Very few of the seeds destroyed by the cone moth larvae fall from the cones when they become mature and open. Much depends on the abundance of the cone crop, as during off years very few cones are produced and a much greater percent of infestation could be expected.

CONTROL MEASURES

Up to 90 percent of cones infested by the larvae of L. miscitata usually fall as soon as mature and open and the remainder during the winter. Some of the larvae remain in the cones until the following spring, and others until the second year after attack. These cones remain open until the wet weather begins late in the fall, and after closing can be separated from old cones by their bright color and the presence of cone moth larvae in the core.

On areas where good reproduction is desired and seed collecting contemplated, a decided reduction in the infestation in the area may be expected if all infested cones are raked into piles and burned between November 1st and April 1st of the following year.

SUMMARY

Very little published literature is available on the life history and the loss to ponderosa pine seed crops caused by the cone moth Laspeyresia miscitata Hein.

Heavy damage to the ponderosa pine seed crop was observed in the vicinity of Coeur d'Alene, Idaho during the spring of 1933 and in 1934, at which time a study was started to secure information on the extent of the infestation and loss to the seed crop. One thousand

cones were collected, 100 each from 10 plots of one acre each, over an area of fourteen square miles. All diameters of cone-bearing trees and all sites were represented. Five hundred of the cones were examined in the field for cone moth attack, and 500 placed in rearing cages and kept outdoors from April 1935 until July 1936. Although a heavy emergence of cone moths and parasites occurred during the first season, it was found that nearly 50% of the cone moth larvae, and similarly part of the brood of four of the six species of associated parasites remained in the cones until the second season after attack. The fact that these insects carried over for two seasons shows their adaptation to the intermittent cone crop of the ponderosa pine. Seed loss on the plots was found to vary from 6 to 62 percent, with an average for all of 28.5 percent. Ponderosa pine seed has a high commercial value due to irregular crops and loss to seed from various agencies. The seed is particularly valuable for nursery plantings and natural reproduction on burns and logged areas.

As the infestation was found to vary for different areas, and it would undoubtedly vary for different seasons, reduction in seed loss over certain areas for seed collecting or reproduction may be expected by raking all infested cones in piles and burning between November 1st and April 1st of the following year.

Respectfully submitted,

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